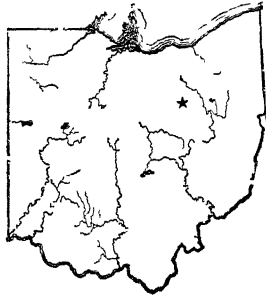


APPLE BLOTCH, A SERIOUS FRUIT
DISEASE

OHIO
Agricultural Experiment
Station

WOOSTER, OHIO, U. S. A., FEBRUARY, 1919

BULLETIN 333



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BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 333

FEBRUARY, 1919

APPLE BLOTCH, A SERIOUS FRUIT DISEASE

A. D. SELBY

The apple blotch has become a very serious menace to apple production in southern Ohio. This designation in "southern Ohio" may mislead since the spread of blotch may extend over practically the whole state.

Early appearance of disease.—While we have no recorded description of blotch as a disease of apple fruit until that made by Clinton from Illinois in 1902, there is the possibility that it may have been present for a longer time. In 1910 it was reported from several localities in Ohio, seven counties in all, and has been followed rather attentively since that date. The collections have increased from seven counties in 1910 to sixteen counties in 1911, and including the counties from which it has since been reported, there is a total of thirty-six counties. Of these counties four are from the northwestern quarter, twelve from the northeastern, eleven from southwestern and thirteen from the southeastern, yet the disease may actually exist in sixty counties, judging from the free rate of spread. The severity of loss has increased in even more emphatic ratios. Note the map prepared by R. C. Walton in 1917 (Fig. 1).

It would seem that Ohio apple growers, in regions where blotch has established itself, are facing apple-blotch control or making firewood from apple trees of susceptible varieties. May we not here have a problem of practical sanitation of the orchard based not on the names of the kinds but rather upon the virulence of the blotch attack, at the time the grower faces the real facts?

The time for waiting is past—unless the woodpile is contemplated—as we shall see further on the matter of disease evaluation of varieties has come to be made a part of practice; then follows its corollary that the disease treatment must be of a character to meet the diseases present and necessarily different for different

varieties where these conditions show such marked variations as we find in apple blotch susceptibility.

Studies of the disease susceptibility of apple varieties in relation to fire blight have been published by the Ohio Experiment Station in Circular 133 (1914), and Bulletin 290 (1915), pages 35-44.



Fig. 1.—Map of Ohio showing distribution of apple blotch occurrences in thirty-six counties, 1910 to 1917. The numbers on the margins to right and left indicate the number of counties reporting blotch within the adjacent one-fourth of the state. (By R. C. Walton.)

While no special publications have heretofore been made by this Station on apple blotch, methods of treatment are outlined in the Spray Calendar, Bulletin 309. Special papers have been presented for apple growers, one in 1911, by W. O. Gloyer, assistant botanist, and later, one by R. C. Walton in 1918. The latter being recent, covers many of the points involved. (See Report Ohio State Horticultural Society, 1918.)

CAUSE OF APPLE BLOTCH

Life history.—The apple blotch disease is caused by the blotch fungus, *Phyllosticta solitaria* E. & E., an imperfect fungus of which we have as yet no perfect or ascus-bearing stage. In brief, the fungus attacks the fruit, twigs and the leaves of the apple, and occurs on wild growths such as the wild crab apple.

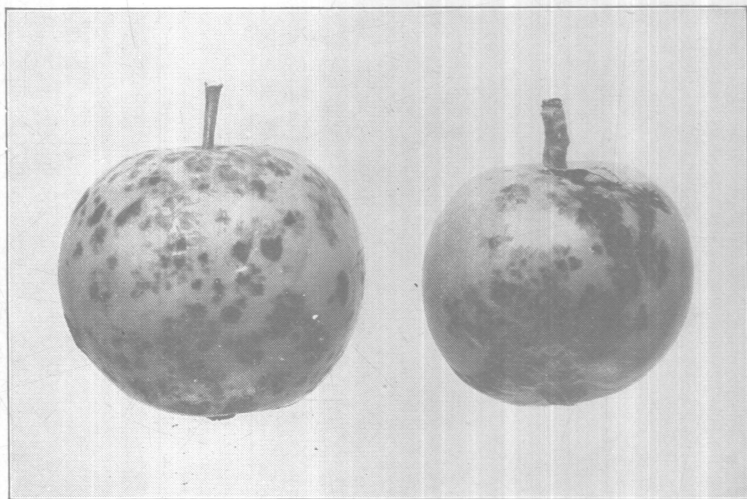


Fig.2.—Blotch upon green apple fruits in mid-season. Variety not recorded

So far as its life history is known it is carried over winter under Ohio conditions in the form of mycelium or threads of the fungus in the cankers formed by it on apple twigs, although not by the diseased fruit.

Later in the season after the growth of the tree is well started there is a formation of spores within the spore-containing bodies seated in the cankers on the twigs. These spores are scattered and attack the young fruit as well as the leaves and twigs of the tree. The period or time of this spore dissemination is important, since the blotches produced on the green fruits develop from the spores.

It is well known that after the blotch or the scab fungus has attacked the apple and penetrated the epidermal covering, it is too late to prevent or control the infection. As Prof. W. J. Green pointed out in the case of scab, many years ago, the application to prevent the disease must be made before the attack occurs. Careful work has been done by Scott and Rorer in Arkansas, by Lewis in Kansas, and later checked up by Roberts in Arkansas and Missouri. All these investigators are practically agreed on the various features connected with the development of the blotch disease, and the treatments required to control or prevent it. All are equally agreed that successful prevention of blotch requires very careful and well-timed treatments.



Fig. 3.—Ben Davis apple in advanced stage of blotch attack. Note cracking and disappearance of the skin of the apple, also pin-head dots of pycnidia of the fungus
(Photograph by R. C. Walton)

BLOTCH ON FRUIT

Characteristics of disease.—On apple fruits the blotch first appears as small, somewhat raised spots which afterwards enlarge rather slowly. In Ohio we formerly believed that the blotch did not develop until late June or early July. However, the writer found it in Washington County on June 22, 1916, and I. P. Lewis, of the

Department of Horticulture of the Ohio Station, observed it upon Ben Davis apples, near Vincent, Washington County, on June 7, 1918. As the season advances, these small dark blotches, or spots, form a dark-fringed or stellate border which gives a striking appearance. This fringed or star-like appearance of the border is best seen through midsummer and becomes merged into darker, oftentimes slightly-depressed spots on the fruit at ripening time. Once recognized, the blotch will not be readily mistaken for other troubles. During the later stage of the spots there are developed small pin-head-like dark spots which are the spore-cases of the

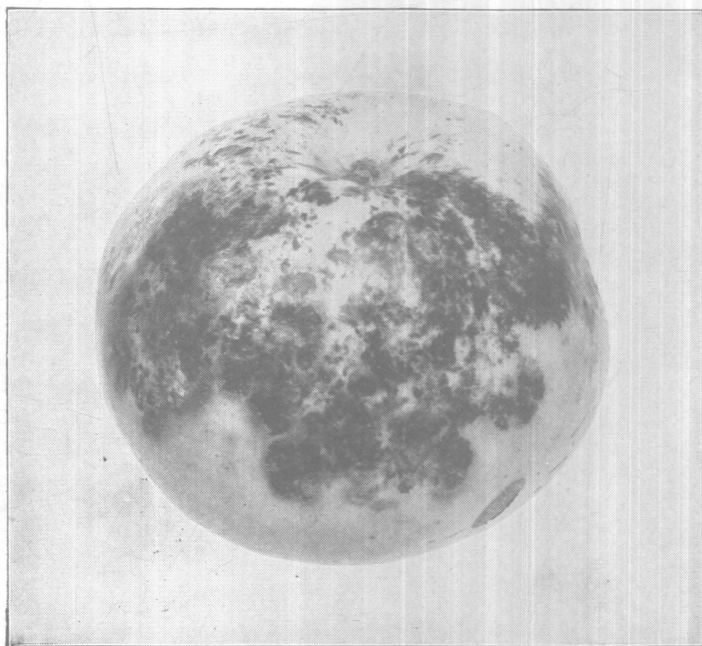


Fig. 4.—Blotch on Paradise Winter Sweet. Contrast this appearance with that of Fig. 3. (Photograph by R. C. Walton)

blotch fungus. They are called pycnidia and may be decidedly scattered or more or less clustered. On some varieties, such as Ben Davis particularly, the behavior of the blotch spot is very characteristic. On the Ben Davis the spot cracks open as shown in the illustration, commonly in three directions from a central point; on other varieties the appearance is more or less distinctive and usually quite characteristic for the variety.

Effect of blotch.—The effect of the blotch is to render the fruit unsightly and at times distorted or malformed, together with other after effects. These are noted particularly in the shrivelling or

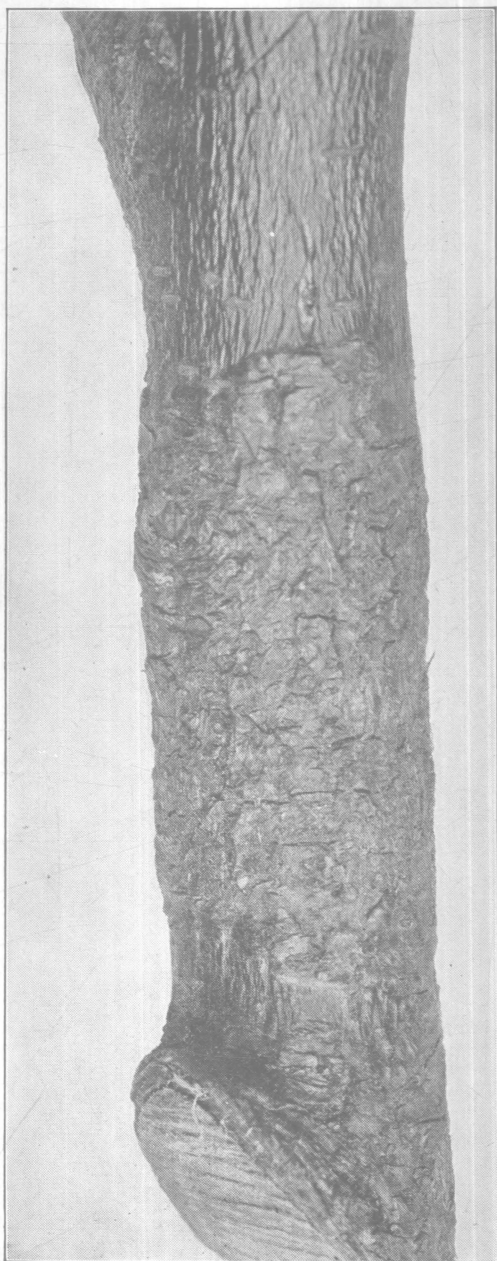


Fig. 5.—Apple blotch canker upon twig. This is the rough canker type. (Photograph by R. C. Walton)

drying of the surface and in the reduced juiciness of the apple. This shows in the reduced yield of cider in apples attacked by blotch.

BLOTCH ON APPLE TWIGS

Means of identification.—On young apple twigs and on water sprouts, blotch is first noticed as a dark area changing to brown, soon dotted with numerous pycnidia. The appearance is very characteristic on water sprouts of Smith Cider variety. Here the elongated or elliptical brownish spots with a distinctly-marked, sunken character, are seen to be covered with the pycnidia of the fungus. Blotch does not usually kill the water sprouts or twigs, but the appearance is distinctive. In other cases twigs show the roughened, canker-like, raised appearance illustrated in Fig. 5. In neglected orchards of susceptible varieties one will find various forms of the cankers. Some of these occur on fruit as well as on water sprouts and other twigs of the tree.

BLOTCH APPEARANCE ON LEAVES

Blotch attacks apple leaves and leaf stalks in a most characteristic manner, but is not so distinctive as in the case of the fruit and twig attacks. In well-marked cases light brown spots are produced in the leaves and light brown areas caused by the fungus are seen on the petioles or leaf stalks. In our observations in Ohio we have met with the spotting of the leaves infrequently although the blotches on fruit and cankers on twigs have been found in great abundance.

LIFE CYCLE OF THE BLOTCH FUNGUS

Necessity of control measures.—Of the life history or life cycle of the blotch fungus, only an outline is sketched. The facts are based upon the publications of others. Scott and Rorer (Arkansas) working together, and Sheldon apart, found that the fungus passes the winter alive in the form of threads or mycelium in the margins of twig cankers. With the coming of spring the mycelium extends and forms spores; from the spores produced in these twig cankers, the young fruit, other twigs and the leaves become infected. Spores may later be produced from spots on the apples, and these spread the disease. Scott and Rorer found practically no spores in the mummied fruits of the previous year and other investigators have since made examinations with the same result. (U. S. Dept. Agr. Bul. 534, Apple Blotch and Its Control, by John W. Roberts.) These facts give us the essential points in relation to orchard sanitation for blotch. **The blotch fungus lives over winter in the cankers on the twigs.** Accordingly, so far as practicable, the sanitation of the orchard calls for removal and burning of these cankers as the source of new infection each season upon the young fruits, other twigs and the green leaves. Remembering that the fungus lives over the dormant period of the tree in the twig cankers, we can trace the infection anew each year. Scott and Rorer found the spores oozing in great quantities from the pycnidia on the twig cankers, and by following this infection from such spores, we are able to work out the other matters. The spores alighting upon other twigs or green fruits, germinate readily and infect the spots where they fall. The various technical characters of the fungus have been followed and somewhat fully treated in the publications mentioned. The time required for the fungus to start development anew in the twig cankers and produce spores which are in turn discharged from the pycnidia, covers several weeks. Doubtless the fungus begins to grow at the beginning of the leaf growth on the tree, and the actual

time required from that stage to spore dispersal has been approximately determined. It is found to coincide with a matter of 3 to 4 weeks after the petals of the blossoms fall.

WHAT IS REQUIRED FOR BLOTCH CONTROL?

Pruning and spraying.—We may conceive that with a small number of trees and very close work, it may be possible to control apple blotch by cutting away all twig cankers showing blotch, and burning these. However, important as this sanitation work may be, in large trees or dealing with the disease in large orchards, it is scarcely practicable. On the other hand, it is not good business foresight to leave an indefinite number of cankers which may be cut away and burned at pruning. The essential treatment required for blotch control is similar to that for control of apple scab and more especially bitter rot. The apple scab infection is early in the season. The blotch infection follows a few weeks after the dropping of the blossoms. Bitter rot infection takes place in mid-summer several weeks after the blotch infection.

The spray to be applied to protect the fruit must accordingly be applied in case of each disease in advance of the infection by the spores which produce the disease. If we have no blotch infection before a given time, then that given time is fixed as a limit for application of spray. Accordingly, it has been found that a spray of Bordeaux mixture applied about 3 weeks after the blossoms fall will prevent the infection of the green fruits which are covered by the spray. Doubtless, we have in this spraying, some killing of the spores as emitted from the cankers. The main fact, however, is the application of the spray upon the green fruits in advance of the infection by these spores. The first calyx-cup spray for codling moth is begun when the petals fall—this fixes the starting date. This was made at Vincent, Ohio, May 6, 1918.

WORK DONE IN BLOTCH CONTROL

Experiments outside of Ohio.—The work of Scott and Rorer, as reported in Bulletin 144, Bureau of Plant Industry, U. S. Dept. Agr., 1909, gave the results of spraying experiments at Bentonville, Ark., and Gravette, Ark. These tests were carried through three seasons and planned in a systematic manner, leaving checks untreated. Those at Bentonville gave a difference represented by 4.9 percent of blotched fruit upon the Ben Davis variety where four sprays of Bordeaux mixture were applied as against 90.3 percent of fruit with the blotch where no treatment was applied, and 66.1 percent of blotch with three sprays begun 3 weeks later. The 5-5-50 Bordeaux

mixture was used in this experiment. Upon the Limbertwig variety, the difference was 5.1 percent blotched apples as sprayed three times with Bordeaux mixture, and 84.9 percent of blotched fruit where no treatment was applied. The experiments at Gravette, on the Ben Davis variety, show a contrast of 7.1 percent of blotch apples on trees receiving four sprays of Bordeaux mixture, 5-5-50 formula, against 55.4 percent of blotched fruit on the checks. The summary of recommendation is as follows:

"Ordinarily four applications of Bordeaux mixture will control the disease: the first, 3 or 4 weeks after the petals have fallen, which corresponds to the second application in the treatment of the codling moth; the second, about 4 weeks later, and the third and fourth at intervals of 3 weeks thereafter. The second and succeeding applications correspond with the treatment for bitter rot, so that one course of treatment will control both diseases. While the disease can be readily controlled by the proper methods, very careful and thorough work is required.

"A few days' delay in making the first application may result in an entire failure, and unless all the fruit is reached and well sprayed only partial success may be expected. The inner and higher portions of the trees, which in practice are often missed, should be thoroughly sprayed, as well as the outer and lower portions.

"Neglect of pruning is conducive to the development of the disease. The fungus accumulates on the numerous twigs, branches and water sprouts of unpruned trees, and these are an ever present source of infection of the fruit. Careful pruning will not only remove a large portion of the diseased twigs but will greatly facilitate thorough spraying."

Lewis' Bulletin, Kansas Agricultural Experiment Station, 196, 1913, gives results of three seasons' experiments, for years 1910, 1911 and 1912, in spraying for blotch control in orchards located in Kansas. He gives the following summary of the test upon Ben Davis variety in 1910:

"The plat sprayed with Bordeaux shows remarkable control, only 2.05 percent being affected with blotch, while in the unsprayed plat 47.1 percent were blotched. Another plat, treated with lime-sulphur, shows more than one-half as much injury as the check plat."

Similar results upon Missouri Pippin are found, receiving the same treatment. He combines the results in his Table 5, page 548, as follows:

TABLE No. 5.—Percent of blotch upon all varieties combined

| | Percent |
|--------------------------|---------|
| Bordeaux spray | 7.42 |
| Lime-sulphur spray | 13.35 |
| No spray | 23.8 |

Results of 1911 upon orchards located at Manhattan and Hutchinson, including two or more orchards at each point, give similar results to those of 1910. He concludes the work of 1912 with the following spray schedule:

“First application.—Apply Bordeaux, 3-4-50, as a mist 3 weeks after the falling of the petals. In case of wet weather, substitute lime-sulphur for Bordeaux. Apply Bordeaux as soon as the weather will permit.

“Second application.—From 2 to 4 weeks after the first application apply Bordeaux, 3-4-50, again as a mist. Use lime-sulphur if the weather is wet. Apply Bordeaux as soon as the weather will permit.

“Third application.—Apply Bordeaux as in the previous applications 10 weeks after the petals fall.

“By adding arsenate of lead at the rate of 2 pounds to 50 gallons of the fungicide, any of the above materials may be made to assist in the control of insects. Such a combination adheres to the fruit and foliage better than the fungicide alone. During an extremely hot, bright spell of weather the lime-sulphur-lead combination frequently causes burning, but during such weather it is advisable to use Bordeaux rather than lime-sulphur.”

A more recent bulletin from the Bureau of Plant Industry, “Apple Blotch and Its Control,” by John W. Roberts, United States Department of Agriculture, Bulletin 534, June, 1917, gives a resume of blotch work and states results of spraying in Arkansas to check the earlier work of Scott and Rorer. Various technical details are closely followed—he gives the following schedule of treatment:

“The disease is controlled by three sprayings with 3-4-50 Bordeaux mixture at intervals of 3 weeks; the first should be completed about 3 weeks after the blossom petals have fallen. Summer-strength lime-sulphur solution may be substituted for Bordeaux mixture where the disease is not severe, thus lessening the risk of injury. The proper time for the first application has been determined both by spraying experiments and by spore germination tests in the laboratory. This spraying schedule differs only slightly from that originally worked out by Scott and Rorer.” It will be

noted that both Lewis and Roberts point out the very much increased difficulty in the control of blotch in cases of severe infection on susceptible varieties.

BLOTCH CONTROL WORK IN OHIO

No systematic, thoroughly-planned blotch control work has been carried through for successive seasons in Ohio. The need for it however is very great, and this need must evidently be met.

Some tentative spray treatments were made at rather irregular intervals by L. B. Yapple, Chillicothe, Ohio, for a period of years. He has a planting of the Mann variety, which at times is quite seriously attacked by blotch, and the adjacent Grimes Golden are also infected. A block of Ben Davis trees located on the other side of the Mann area is reported to have shown very slight infection by blotch. In the years when the writer advised Mr. Yapple, we had no data of very early appearance of blotch infection on green fruit; accordingly, it was suggested that the use of Bordeaux mixture in combination with the arsenate of lead for codling moth the first week of July, with repetition of the same spray 2 to 3 weeks later should control blotch. One or more of the seasons, when this plan was carried out, fair results were reported. When the spray was delayed until after the middle of July very poor results were naturally secured.

Plans were made to conduct experiments on the orchard of the Washington County Experiment Farm at Fleming. This orchard contained a number of varieties including several trees of Smith Cider, very badly infected, and some other varieties such as Stark and Rome. The orchard was treated during two seasons with more or less care, but without any very decisive results. It was here that the writer, by collecting the blotch upon fruits, June 23, 1916, recognized the unsound basis of the plan to begin spraying for blotch as late as July. Other factors contributed to abandonment of these efforts. Local occurrences of blotch infection on Rome Beauty, in the orchard of that variety at the Southeastern Test Farm, Carpenter, was followed through two seasons. No applications of spray were made aside from the ordinary scab and codling moth schedule. Some cooperative tests have been made in Clinton and Highland counties under the direction of Prof. R. B. Cruickshank, of the Extension Service, Ohio State University. This outcome in Ohio is decidedly variable, because in no case contemplating a sufficiently thorough going experiment on that control.

As before stated, blotch control is not an easy problem and cannot very well be put aside.

VARIETIES SUSCEPTIBLE TO BLOTCH

We will probably modify our estimates of relative susceptibility of varieties to the blotch disease with longer observation. However, we have very decided evidence upon several varieties. We may list as follows:

| Most susceptible | Less susceptible |
|-----------------------|------------------|
| Smith Cider | Maiden Blush |
| Stark | Grimes Golden |
| Missouri Pippin | Rome Beauty |
| Mann | Stayman Winesap |
| Ben Davis (?) | Gano |
| Northwestern Greening | York Imperial |
| Limbertwig | Jonathan |
| Oldenburg | Winesap |

The relative behavior of varieties in Ohio has been different in a minor way from that reported for the southwestern district, and as before stated, is in process of a more thorough development through study.

BLOTCH CONTROL POSSIBLE IN OHIO

Methods of promise.—It is clearly indicated by success in the Ozark Mountain district in blotch control and by the extension of this control into Kansas and portions of Missouri, that blotch control is practicable and relatively profitable. This is supported by the minor work heretofore done in Ohio.

It is a matter of years to change the varieties in any apple orchard or to grow new ones into bearing. It may be a matter of only 2 or 3 years' effort to save the apple crop on these trees through changing methods of spray treatment. It would seem the part of good business investment for the grower to make this change rather than to lose returns from the orchard or have them diminished through blotch. The following suggestions are offered in the form of recommendations for modified orchard practice and are based upon the work done outside of Ohio.

Proposed plan for orchards of mixed kinds.—Where two or more varieties are planted together in orchards and one is very susceptible to blotch, special consideration seems necessary for the susceptible variety. If it be a fairly good commercial variety, such as Mann, Stark, Limbertwig, then it would call for special handling to conserve the crop and protect less susceptible varieties from blotch infection. (See p. 502.) If the variety be an inferior commercial sort with no strong market characters, as in the case of Smith Cider, which is commonly present in the form of only a few trees in the orchard, then these trees promise more service as fire-

wood than as sources of infection to others. The Ben Davis has proved so much less susceptible to blotch than Stark, Mann or Northwestern that it takes a less prominent place in the first series. In case the very susceptible varieties like Stark and Mann are represented by well developed trees in good vigor and promise, they are probably well worth the effort at sanitation for the blotch. If, on the other hand, they are represented by only a few partly dead trees of these varieties, or of varieties like Northwestern and Ben Davis, Missouri Pippin or even Maiden Blush, it is probably wiser to destroy such trees than to be subjected to the risk of the infection by their presence. Having reached a decision and the wood pile stock duly cared for, the orchard practice may be decided upon.

Plan for orchards of one variety.—In orchards of one variety which is decidedly injured by blotch attack, as with Ben Davis, Rome Beauty or Grimes, it seems well to prune the orchard and to follow a uniform plan based upon the needs for blotch control and begin with such as a spray of Bordeaux II applied with arsenate of lead 3 weeks after the petals of blossoms fall.

No orchard is worthy the expense of fertilizing and spraying unless properly pruned, and in this pruning, especially upon very susceptible kinds, diseased water sprouts and badly-cankered twigs and dead branches of any kind call for removal and early burning. Only personal contact with an orchard can enable one to judge as to the plans to be followed in this pruning and preliminary preparation for the season's treatment. Unless the trees are first properly pruned and are of sufficient vigor to produce fruit of fair size and appearance, the expense of spraying for blotch or any purpose seems of doubtful merit. However, if the trees are not worth this expenditure and not worthy of fertilizing preparatory to blotch treatment, they are not worthy to remain standing. With orchards of Ben Davis, Gano, Wagener, Rome Beauty and other varieties which have showed less injury from blotch than the kinds first mentioned, the same thorough-going care is advisable in pruning to remove water sprouts and other types of twigs that are attacked by the blotch cankers.

Regarding apple blotch Prof. W. J. Green, of the Department of Horticulture, says: "If one comes to the conclusion, after unsatisfactory results in the treatment for apple blotch that the disease is uncontrollable, he should hesitate before deciding upon destruction of the trees. In case the trees are very old and much enfeebled, and numerous vacancies are found in the orchard, heroic treatment may be advisable. If, also, the varieties are inferior

and very susceptible to the disease there may be no alternative but destruction of the trees. Under certain conditions, however, it may be possible to save the trees and make them useful for a long period.

Trees that are not too old for top grafting may be worked over into some good and non-susceptible variety. When conditions are right and the work properly done this ought to be a satisfactory operation.

Trees that are young and vigorous may be top grafted in one operation. Old trees may be worked over within 2 or 3 years. In either case there must be severe pruning done, which gives opportunity to get rid of the cankers. Spraying is also facilitated, permitting thorough work. If the trees have been planted only 2 or 3 years they may be top grafted by cutting off the entire top about 2 feet from the ground and inserting one scion, thus forming a complete new top. If the trees are a few years older and have formed tops as many grafts as need be may be inserted in the top and side branches. Usually trees 5 to 15 years old are susceptible to such treatment.

In case of older trees care must be taken not to cut too severely in any one season.

There is no good reason why trees of any variety may not be made over in this manner, and in a much shorter time than young trees could be planted and brought into bearing. The Mann apple, having a poor root system, is not suited to the purpose but Stark, Smith Cider and Missouri Pippin will be found to be satisfactory, if the work is properly done."

As pointed out by both Lewis and Roberts where there is a very high percentage of infected fruits in an orchard the protection of all clean fruit is a serious difficulty. Accordingly, if efforts are made to control the blotch, these efforts deserve to be thorough-going and not sporadic or half hearted. There is nothing in the records of previous investigations to justify the hope that blotch may be controlled by the standard outlines devised to control scab, codling moth or even bitter rot, on the commercial varieties. It appears that spraying with Bordeaux mixture and in the early June period is called for as the first measure in spray control. It will be indeed fortunate for Ohio if a shift of the second spray for codling moth to this period gives equal results compared with the earlier one of the spray calendar. (See p. 505.)

Bordeaux mixture.—The strength of Bordeaux mixture has been nearly standardized for Ohio. Following the early work with the 4-4-50 formula which is given in our spray calendar, Bulletin

309, as Bordeaux I, it is pointed out that this strength properly made is as effective for fruit spraying as any other formula. The 4 pounds of copper sulphate designated seems to furnish enough of the copper sulphate. The 4 pounds of lime means the quick-lime, not the hydrated lime. Where hydrated lime is employed one-fourth more is required, thus in practice it may become a 4-5-50 formula, which in the spray calendar is given as follows:

"Bordeaux I—

Copper sulphate (blue vitriol), 4 pounds
Quicklime (not air slaked), 4 pounds
(Air slaked lime not good; hydrated lime one-fourth more)
Water to make 50 gallons."

This is given to correct any misunderstanding by those who would use the spray.

Dilute Bordeaux mixture or the Bordeaux II of the Ohio formula is a 2-2-50 formula, being based upon 2 pounds of copper sulphate, 2 pounds of stone lime, hydrated lime $\frac{1}{4}$ more, water to make 50 gallons. It has not seemed, from our experience in Ohio, that any greater strength than the Bordeaux II is required for use upon apple trees in foliage. However, relative testing may change this viewpoint. If only hydrated lime may be easily secured, then the formula may become copper sulphate 2 pounds, hydrated lime $2\frac{1}{2}$ to 3 pounds, water to make 50 gallons.

SPRAY SCHEDULE RECOMMENDED FOR TREATMENT OF APPLE BLOTCH

ON STARK, MANN, SMITH CIDER, ETC.

First spray—Two weeks after petals drop, Bordeaux I, or 2-4-50 formula, arsenate of lead.*

Second spray—Two weeks after first, Bordeaux I or 2-4-50 formula.

Third spray—Two weeks after second, Bordeaux I or 2-4-50 formula, arsenate of lead.

Fourth spray—Two weeks after third. Bordeaux II, 2-4-50 strength or ammoniacal copper carbonate.

ON BEN DAVIS, GANO, GRIMES, ETC.

First spray—Bordeaux II, two weeks after petals drop, 2-4-50 formula, arsenate of lead.*

Second spray—Two weeks after first, Bordeaux II.

Third spray—Two weeks after second, Bordeaux II, and arsenate of lead.

Fourth spray—Possibly not required. If applied, use Bordeaux II.

*Prof. H. A. Gossard, of the Department of Entomology, Ohio Experiment Station, states that judging by experience of recent years the second spray of arsenate of lead for codling worm may properly be made at the time of this first spray recommended for blotch, namely, about 2 to 3 weeks after the petals fall; or it may be combined with the second blotch spray, 4 weeks after the petals fall. The application should then be regarded as a preventive of side injury and the first spraying should be very thorough to prevent entrance of the worms at the calyx end.